HCC 04: Bioretention systems (Raingardens)

1. INTRODUCTION

This practice note[1] has been developed to provide general information on the minimum design and sizing requirements for bioretention systems which are used in residential and non-residential applications for on-site stormwater management. Design information is provided for a bioretention device designed to provide full water quality treatment and extended detention, and also for a bioretention reduced at-source measure sized for a smaller contributing catchment, refer to Sections 2 and 3 below.

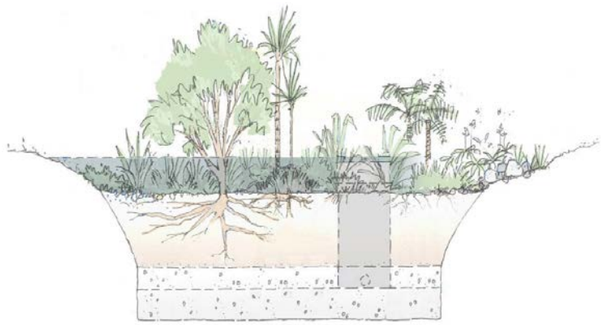
1.1 Bioretention systems

Bioretention systems are specially designed garden beds which filter stormwater runoff from surrounding areas or from stormwater pipes. Bioretention is widely accepted as one of the best stormwater management practices. It makes uses of the chemical, biological and physical properties of plants, microbes and soils and is an effort to mimic nature. Plants in a bioretention system transpire some of the water that is directed into it back into the atmosphere. Unlined bioretention systems allow infiltration of stormwater into the underlying soils, hence volume reduction. Bioretention devices also provide water quality treatment through the filtering that occurs through the soil media layer.

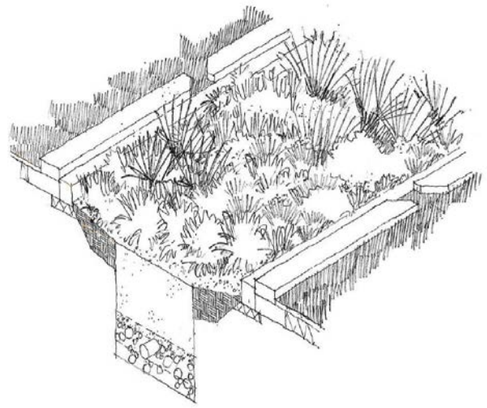
In this practice note, bioretention encompasses a number of different devices, including:

- Raingardens
- Bio-retention swales
- Stormwater planters, and
- Tree pits.

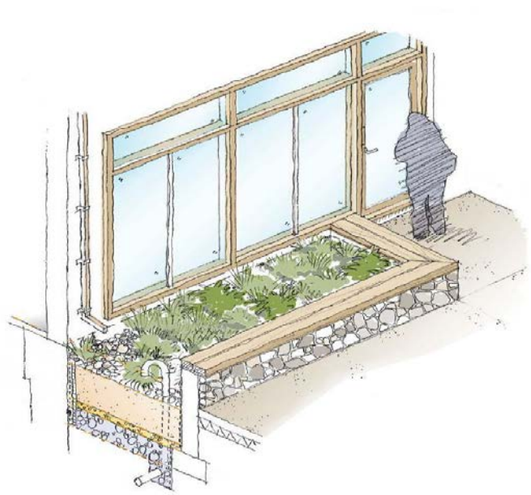
A **raingarden** is essentially a sunken garden with good well drained soil and an underdrain to which stormwater is directed.



A **bioretention swale** is a long narrow sloping swale with a bioretention system along the base of the swale. It can be used to convey as well as treat stormwater.



A **stormwater planter** is an above ground garden in a large container with bioretention soil media and an underdrain to which stormwater is directed.



Tree pits which are used for planting trees along streets can also be used for bioretention as long as they are designed with an appropriate underdrainage system.

1.2 Advantages of a bioretention system

Bioretention offers a number of benefits which is why it is one of the preferred methods for on-site stormwater management. The benefits include:

- ***Improved water quality by treating and filtering out contaminants.***
- ***Improved hydrological response of stormwater peak flow and volume, especially for smaller rainfall events.***
- ***Providing amenity and increased vegetative cover.***
- ***Utilises the same space as is normally used for gardens.***
- ***Providing better growing conditions (free draining soils) for plants and thus improves the garden, and***
- ***Mimics nature and uses natural processes.***

[1] Three Waters Management Practice Notes are Hamilton City Council controlled documents and will be subject to ongoing review. The latest version can be downloaded from the Hamilton City Council website: http://www.hamilton.govt.nz/our-council/council-publications/manuals/Pages/Three-Waters-Management-Practice-Notes.aspx

2. BIORETENTION – FULL TREATMENT

2.1 Minimum design requirements

The following information is intended as a guide only. All bioretention systems within Hamilton City require specific design by a suitably qualified person and approval from Hamilton City Council's Building Control Unit.

General design requirements are presented below. Figure 1 presents the typical layers within a bioretention system:

1. **Size and shape:** Bioretention systems can be any shape. Shapes that blend in with the site can improve site amenity and look more natural. Bioretention systems are to be designed to cater to stormwater runoff from impermeable areas at your property. The bioretention system size refers to the AREA that is filled with planting soil mix and should be sized so that it has an area equivalent to 2% of the impermeable area draining it to provide water quality treatment, or 5% if providing extended detention and water quality treatment. The minimum size for a bioretention system is 2m^2.

2. **Location:** Devices should be located so that stormwater can flow to the device under gravity. **The bulk and location of the bioretention system shall be in accordance with the requirements for onsite soakage systems, including being above the winter high water table**[2].

3. **Inlet design**: Good inlet design is essential for a bioretention systems to work. The most important thing to consider is that the water must be able to flow into the device. Flow should be directed into the device in a sheet flow over a vegetated filter strip if possible, and should always flow into the device in a manner which avoids concentrated flows and scour. If possible high flows should bypass the device.

   For household raingardens the inlet can be provided with a factory made PVC flow spreader, a cost effective option.

4. **Planting soil mix:** The main component of the bioretention system is the planting soil mix (refer to Section 4 for more details). The minimum soil depth is 600mm (500mm of planting soil mix and 100mm transition layer) which should be increased to at least 1m when trees are planted.

   For rain gardens, stormwater planters and tree pits the surface of the planting soil should be flat and level to avoid localised ponding and blinding, while for bio-retention swales the surface should be gently sloping. Soil compaction should be avoided, allowing natural compaction only. Install materials in 300mm layers and soak with water to aid natural compaction. Depending on the soil material, up to 20% natural compaction may occur over time.

5. **Plants:** Native plants are preferable but not essential. Any plants which suit your garden may be used. The plants should be able to tolerate short periods of inundation and longer dry periods, be perennial rather than annual, have deep fibrous root systems and have spreading rather than clumped growth forms. Note that the use of wetland plants is not recommended as these plants are not well suited to free draining soils.

6. **Mulch:** 50-100mm surface mulch layer. Note that the depth of mulch should be taken into account when setting the overflow level. Ensuring stormwater runoff doesn't wash mulch into drains and cause blockages can be addressed by good device design and selection of a mulch material that doesn't float.

7. **Under drain:** Bioretention systems typically require under drains. The under drain should be a perforated PVC pipe with a minimum diameter of 100mm and should have a minimum slope of 0.5% (5cm over 10m). For bioretention areas up to 10m^2 a single 100mm diameter pipe will suffice, for areas between 10m^2 and 20m^2 a single 150mm or two 100mm diameter pipes will suffice. For areas larger than 20m^2 a site specific design is required. Under drain spacing - there should be one under drain per 3m width of bioretention system.

   Under drains should be evenly spaced along the length of the device. They should be placed 75 to 300mm above the bottom of the drainage layer where no liner is present to allow for infiltration into the in-situ soils, or on top of the liner if one is used. There should be at least 25mm of drainage layer above the top of the under drain. The underdrain shall be connected an approved stormwater outfall in accordance with Council's drainage hierarchy.

8. **Liner:** An impervious liner is required when bioretention is used in geotechnically unstable or steep sites greater than 1V:5H. The use of stormwater planters should be considered in these situations.

9. **Geofabric:** The use of geofabric in the construction of bioretention systems is generally not recommended.

10. **Root barrier**: Consider using a root barrier when there are susceptible services such (as sewers), or foundations nearby. These are likely to be at risk from root penetration. The root barrier should only be placed adjacent to the services which require protection and not around the whole device.

11. **Filter layer:** A filter layer is required between the planting soil and the drainage layer. A geofabric is not recommended for this purpose. The filter zone should consist of 50mm of pea-gravel (US #8 (1.18mm - 9.5mm) with 50mm of washed sand (0.5mm – 1mm) on top.

12. **Ponding depth:** Ponding should normally be designed for a depth of 200-300mm above the bed of the device.

13. **Overflow:** Ideally, when the capacity of the rain garden is exceeded, flows should be by-passed to an overflow located outside the rain garden. If an overflow is located within the rain garden then the overflow can be by means of a pipe/manhole which connects into the underdrain system, or it could be a gravel curtain which connects into the drainage layer.

    For household raingardens the overflow can be provided as a 100mm vertical pipe connecting to the underdrain with an elbow bend. When the raingarden is finished the overflow pipe should sit 100mm below the top edge of the raingarden and 100mm above the mulch level. Apply a cap or tape the top of the overflow pipe during construction to prevent debris entering the underdrain.

14. **Access:** Suitable access needs to be provided for routine maintenance. Small residential gardens may require access for a wheel barrow, while larger commercial gardens will require more substantial access, suitable for a small excavator.

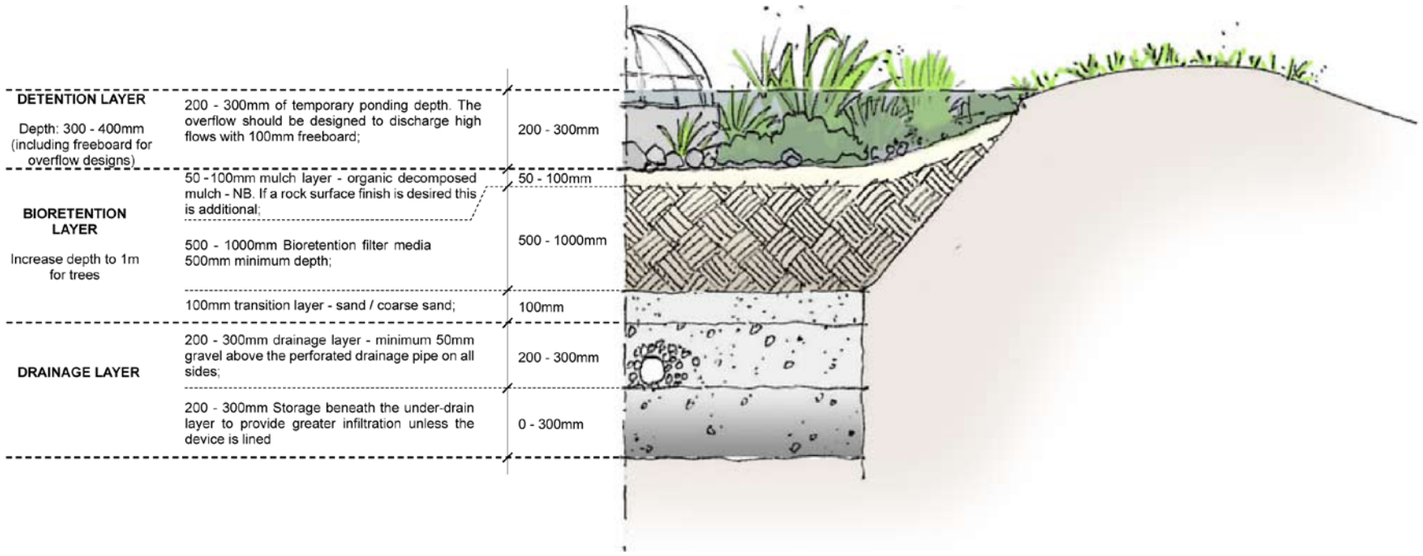


Figure 1: Typical bioretention layers (images here and above from NSCC Bioretention Guidelines July 2008)

[2] Refer to Practice Note HCC 03: Soakage

3. BIORETENTION – REDUCED AT-SOURCE MEASURE

If there is an approved downstream stormwater management device providing stormwater flow attenuation and stormwater quality treatment for your site, you can provide bioretention on-lot designed as a reduced at-source measure only, referred to bioretention reduced (refer to HCC01 Overview for further discussion about this topic).

3.1 Minimum design requirements

The following information is intended as a guide only. All bioretention systems within Hamilton City require specific design by a suitably qualified person and approval from Hamilton City Council's Building Control Unit.

A bioretention reduced device should be designed in accordance with the minimum design requirements described above for the bioretention full treatment device, except the size of the reduced device is assessed differently, as outlined below:

a) The bioretention reduced device is designed to cater to stormwater runoff from impermeable areas where cars drive and park at your property. The bioretention reduced device should be sized so that it has an AREA equivalent to 2% of the impermeable trafficked areas draining to it (i.e. roof area does not need to drain to a bioretention reduced device). The device should be located in such a way to maximise the collection of site runoff from trafficked areas. Refer to Figure 2 below for an indicative schematic of the typical arrangement for a bioretention reduced device. Ensure overflow from the device drains to approved overland flowpath.

b) Refer to Section 2.1 Minimum design requirements for all other details.

c) It is important to ensure the bioretention device is above the winter high water table as per 2 in Section 2.1 above.

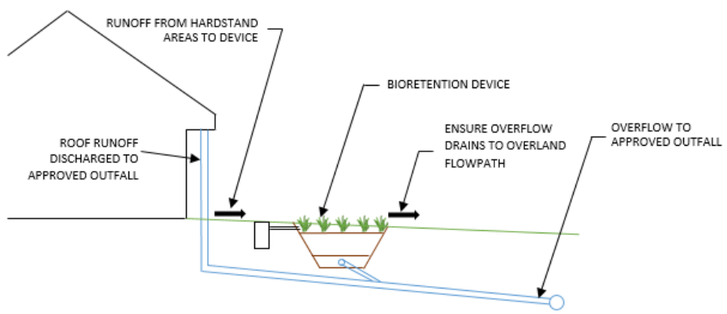


Figure 2: Schematic showing typical arrangement for bioretention reduced

3.2 Example

The following example clarifies how to size a bioretention reduced device for a 500m^2 lot with:

- 250m^2 house and garage
- 125m^2 driveway and associated hardstand area (all trafficked)

The bioretention reduced device is designed to cater to stormwater runoff from impervious areas where cars drive and park. For this site this equates to 125m^2. The bioretention reduced device is sized to have an area equivalent to 2% of the contributing catchment.

Area of bioretention device = 125m^2 x 2% = 2.5m^2

The remaining design parameters for the bioretention reduced device are determined in accordance with Section 2.1 of this practice note - Minimum design requirements.

3.3 Indicative bioretention reduced device sizings

The following table outlines indicative bioretention reduced device sizings for a range of connected impervious areas:

Lot area (m^2)	Bioretention reduced area (m^2)
50	1
100	2
150	3
200	4
250	5
300	6
350	7
400	8

4. BIORETENTION FILTER MEDIA

The bioretention filter media is required to support a range of plants (groundcovers to trees) that are adapted to freely draining soils with occasional flooding. The filter media should generally be a **loamy sand** with high permeability under compaction and should be free of rubbish and weeds. The filter media should contain some organic matter for increased water holding capacity but be low in nutrient content.

General specifications for bioretention filter media are listed below:

- A mix of **mature** compost (approximately 15-25%), soil (approximately 15-25%) and sand (approximately 60%) is recommended. Allophanic (Ash) or Pumice Soils are preferred. Poorly structured clay or silty clay soils should not be used. Pumice sand is preferred.
- A uniform mix, free of stones, stumps, roots or other similar objects and free of brush or seeds from noxious plants.
- Hydraulic conductivity of 50 – 150 mm/hr
- Organic matter content at least 2% (w/w)
- Seed germination score of 6 (out of 7)
- pH range 6 – 7.5

5. CONSTRUCTION

Ideally bioretention systems should not be built until the rest of the site has been constructed and the site stabilised. They must be protected from stormwater flows carrying high sediment loads during construction activities from your site or neighbouring sites. If they are not protected during construction then the planting soil mix will need to be replaced. If work on the bioretention system needs to commence before the rest of the site is stabilised then the device should be constructed, but not planted, and covered with a geofabric and topsoil. This will later be removed and the device planted once the rest of the site has been stabilised.

6. MAINTENANCE

One of the important considerations with bioretention systems is long-term maintenance. Remember that a bioretention system is a garden and not just a drainage system – they are generally low maintenance, not NO maintenance.

They need water when it doesn't rain until the plants are established. During dry periods the under drain in the bioretention systems may cause the planting soil to dry out. Watering the vegetation on an as needed basis helps ensure a healthy condition and appearance.

- Mulch annually with hardwood mulch as this suppresses weeds and retains moisture.
- Every few years' excess mulch may need to be removed.
- Weed regularly as you would with any garden.
- Don't park or drive on the device as this causes compaction and leaves ruts.
- Don't let (fine) sediment build up – if a crust forms remove it & rework the top layer of soil.
- Keep an eye on the plants – if they are unhappy they may need moving. Plants may need pruning, thinning or replacing from time to time.
- Strong water flows may cause erosion, this will need to be repaired and measures put in place to prevent recurrence.
- Check the overflow for clogging and remove any build-up of rubbish or debris regularly.

7. SUMMARY OF PLANNING REQUIREMENTS

Your bioretention system must be consented either as part of the whole site's building consent or as a separate building consent.

For details on building consents please contact Hamilton City Council's Building Control Unit phone (07) 838 6699.

Bioretention systems are required to be designed by a suitably qualified person based on this practice note, council's Infrastructure Technical Guideline and other best practice guidance. As-laid plans, authorised by a registered installer, are required for the drainage components of the bioretention system and shall be provided to council.